Intel Labs

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Silicon Technology and Manufacturing

Leading the Way to Faster More Powerful and Less Expensive Digital Products

For over 30 years, Intel has responded to the challenge of how to put more digital speed, power and value onto smaller chips of silicon. Today we're continuing to find new ways of breaking the barriers to Moore's Law. The world's appetite for faster, more powerful silicon-based microprocessors at less cost shows no sign of abating. As the leader in silicon process technology and high volume silicon manufacturing, Intel feeds this hunger at virtually every level, providing the building blocks of the Internet economy and helping to advance computing, communications and wireless information technologies.

Extending Moore's Law

Gordon Moore, Intel co-founder and Chairman Emeritus, predicted in 1965 that technology improvements would cause the number of transistors per integrated circuit to double every 18-24 months. Moore's Law has remained remarkably constant. We're working on the advances in silicon technologies to extend it into its fourth decade. We're averaging twice the chips produced per wafer every two years at half the cost per transistor.

Bigger Wafers Mean Bigger Savings

We've introduced a new microprocessor manufacturing technology every two years for the last decade. Our latest is the 130 nanometer (0.13 micron or µm) generation which will be processed on another recent breakthrough, the 300 millimeter (12-inch) diameter silicon wafer. These wafers will yield 240 percent more chips than our current 200 mm (8-inch) diameter wafers. The 300 mm wafers should also help us cut manufacturing costs by 30 percent and consume 40 percent less energy and water.

Billion-Transistor Microprocessors

Extremely small transistors are the key building blocks for fast microprocessors, the brains of computers and countless other smart devices. We've demonstrated the ability to make 20 nanometer (nm — billionth of a meter) transistors, the fastest and smallest announced by researchers worldwide. This will enable us to produce billion-transistor microprocessors running at speeds approaching 20 gigahertz (GHz) and operating at less than one volt in the 2007 timeframe. By comparison, today's fastest Pentium® 4 processors have 42 million transistors and operate at 1.7 GHz. We're also working to solve some of the problems of manufacturing extremely small transistors — high gate leakage, for example — with materials called high-K dielectrics. These new materials have been demonstrated to reduce gate leakage by up to 100,000 times.

Flash Forward to a New Era of Wireless Devices

Having shipped over a billion flash memory chips, we're now developing a new process technology for combining a microprocessor, flash memory and analog communications circuits on a single chip of silicon. It's three chips in one. This "wireless-Internet-on-a-chip" technology could produce fast digital cellular data phones capable of going a month between battery charges and offering all the programmability and functionality of a handheld computer.

The Best Things Come in Smart Packages

As processor performance increases, so does the demand on the packaging of the chip. There are complex thermal, power delivery and signal integrity challenges, as well as the need to boost system-wide performance by providing faster connection speeds to devices outside the chip. We're working with substrate materials suppliers plus universities and government labs to develop new materials and processes for the next generation of chip packaging, searching for new materials and processes that meet our technical and environmental goals.

The Smallest Machines on Earth

Through acquisitions and other investment, we're now getting involved in Micro Electro-Mechanical Systems. MEMS is a technology similar to silicon technology — both deal with the ultra small. We're looking at ways ultra-microscopic electro-mechanical systems machines can be combined with integrated circuits on silicon for applications such as wireless communications, biomedicine and micro-refrigerators in chip packaging to cool ultrafast microprocessors.

A Cleaner Way to Work

A significant portion of our R&D is in environmentally friendly manufacturing. We've significantly reduced our water and power consumption through more efficient manufacturing techniques and are researching new ways to conserve. We are also looking into alternative chemicals to replace solvents used in microprocessor manufacturing that could pose air pollution threats. Being a company devoted to success in the long-term means being a caretaker of the planet as well.

The Shape of Things to Come

Our advancements in process and high volume manufacturing technologies form the basic building blocks for the massive worldwide information infrastructure construction project known as the Internet economy, which increasingly should drive the "New Economy." The success of our work underlies the entire revolution in the way we as a society do business and process information.

About Intel Labs

Intel Labs are the R&D arm of Intel. We have more than 6,000 researchers and scientists in 80 labs around the world. Our decentralized structure allows us to tackle a broader range of research projects. The labs are closely aligned with Intel's business units and focus on R&D for technologies and products that specifically address the needs of our customers.

Designing the Future

Find out more about Intel Labs by visiting www.intel.com/labs. For more on these advanced technologies, visit our Silicon Showcase at www.intel.com/research/silicon The digital world of tomorrow is in our labs today.

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